FINAL REPORT

Rec'd 20 June 1966

PHASE I

[redacted]

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SUMMARY

This report describes the appraisals made of the problems anticipated and experienced in the production of a breadboard model of a STAT wide film [redacted] The problems were defined as being those of the curl action of the wide film, uniformity of the air and liquid cushions forming the main principles of the [redacted] system, and dependent upon, STAT this in part, the uniformity of chemical reaction in the different process steps.

A test program was conducted to determine the actual severity of these problems, and solutions proposed. Other secondary problems such as the selection of basic construction materials were also considered, test hardware manufactured and evaluation tests conducted. This work essential to the success of the breadboard model was satisfactorily completed, and the breadboard designed and constructed in this phase of the program.

SECTION 1

1. INTRODUCTION

The objective of phase 1 of this program was the design and construction of a preliminary (breadboard) model of a Processor based on the results of studies applying the [ ] principle to the processing of 9-1/2 inch wide photographic film. STAT

The breadboard model was built to enable a sensitometric program to be undertaken to determine the necessary design and functional parameters for the manufacture of a prototype 9-1/2 inch [ ] Processor. STAT

The breadboard processor is now available and fully operational for the sensitometric evaluation program.

SECTION 2

TECHNICAL DISCUSSION

2.1 The [redacted] principle, to date, has been successfully applied STAT to the processing of 16, 35, and 70 m/m width film only. On the basis of experience gained from these narrower width films, the application of the Sepratron principle to wider films was not expected to create serious basic problems. Certain problems were however, anticipated, and on these a large percentage of the program effort was expended.

2.2 Problem Areas and Solutions Obtained

Three major problem areas were anticipated as requiring primary attention. These were as follows:

1) The strong curl action of the wider 9-1/2 in film about its long axis.

2) The obtaining of uniform action of the air and liquid cushions on which the film is transported.

3) Chemical reaction in relation to turbulation in elevated temperatures.

Parallel with the problems outlined above, other problems of a secondary nature but vital to the production of hardware, such as the selection of basic construction materials were also given early consideration in the program.

2.3 Film Curl

Photographic film is not an homogeneous material, it consists of a silver halide carrying gelatin emulsion, coated on a transport flexible

base, such as cellulose estar. This structure may vary between film types by changes to the composition of the gelatin, or the base, or by the coating of another layer of gelatin on the opposite side of the base, as a method of controlling curl. Curl of photographic film occurs as a result of the difference in moisture capacity of the components. Gelatin is very hygroscopic and the base material relatively the opposite, or non-hygroscopic. For this reason various types of film, exhibit different characteristics of curl, and as a result, feeding of such curled film through [redacted] process STAT modules was expected to result in mechanical damage, if the impingement action taking place on both sides of the film, failed to apply sufficient flattening action to the curl. The film in this case would show scratches down the middle, since both outside edges and the highest point of the curl, in the middle of the film would contact the module. In other words the air and liquid cushion action on which the film rides, would not be effective. Two solutions were investigated:

1) To adapt the shape of the film passage in the module to suit the shape of the curled film.

2) To design the air and liquid passages so that the pressure would force the film into a flat condition.

The first approach was considered and after a thorough investigation, discarded for the following reasons:

1) A curved surface shape to the film passage would produce differential pressure and turbulation across the width of the film, which would be difficult to control, and would furthermore create additional problems in the use of different film widths.

2) Due to the tendency towards very thin film bases, and the increasing use of non-curl backing, a situation would be created where non-curling films were processed in curved process channels.

3) Complication in the construction of the modules. An extensive series of testing and evaluation was carried out parallel with the curved passage investigation to determine the requirements of a straight non-curved passage that would cope with curled film.

Early tests with experimental clear lucite models employing smoke, showed that if the air passing between the channel walls and the film, maintained a certain velocity at a constant pressure a non-collapsible air cushion was formed having the required properties. Many model air and liquid passages very similar in shape and form, incorporating small changes between air and liquid passages to compensate for density changes in the air and liquid mediums were built, and tested to provide the data for the final design selected.

2.4 UNIFORM AIR AND LIQUID CUSHIONS IN [redacted] PROCESS MODULES

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The determination of the right air and liquid channel parameters to combat the film curl, was also correlated to the problem of providing a uniform air and liquid cushion to maintain a proper film transport condition. By considering this requirement and conducting parallel tests on the experimental air and liquid channels, the final shapes determined, satisfied both requirements.

It should be stressed that in problems of this nature, theoretical solutions can only be proved by extensive experimental work, in which minor changes produce large differences in results.

2.5 CHEMICAL REACTION IN RELATION TO TURBULATION IN ELEVATED TEMPERATURES

A test program with photographic film in 35 and 70 m/m modules was conducted to determine the effectiveness and the correlation between

high liquid turbulation and elevated temperatures, in terms of the increase in density obtained.

These tests were important in establishing the parameters of the final [redacted] module and its construction. STAT

The numerous tests conducted crystallized very clearly an optimum relationship between turbulation and elevated process temperatures. High agitation becomes most effective between normal conventional process temperatures of $68^{\circ}F$ up to $100^{\circ}F$.

The cross over point between the two occurs between $100^{\circ}F$ and $110^{\circ}F$ where further increases in turbulation have decreasing effectiveness, but elevated temperatures continue to be effective.

The establishment of these parameters greatly influenced the design and construction of the final module.

2.6 FINAL [redacted] MODULE STAT

The information resulting from test programs previously described considerably affected the original general design of the process chamber. The determination of the relationship between turbulation and elevated process temperatures in the area of $100^{\circ}F$ to $110^{\circ}F$, established that it would not be necessary to continually increase the rate of turbulation to gain higher processing speeds, specially in the developer module. The replacement of a high turbulation zone in the film channel with a normal turbulation rate zone permitted a simplification of the method of joining the two sections of a processing module. The practice on the 16/35 mm modules necessitated that the joining channels between modules be mounted with better than .002 inches accuracy. Now, since the two process areas are joined together in one mechanical component, less attention to the accuracy factor, is required, resulting in an improvement in the reliability and simplicity of the overall design.

2.7 CONSTRUCTION MATERIALS

Evaluation tests were conducted with various materials to determine the most suitable material from which to manufacture the process modules. The increase from 16 mm and 35 mm process modules to 9-1/2 inch modules, especially in conjunction with elevated temperatures, was a matter of considerable concern.

In early tests, Polyurethane was used with good results concerning castability, absolute temperature stability and resistance to chemical corrosion. In other respects, however this material did not prove satisfactory. Machining proved to be very difficult due to flexibility of the material, and additionally the cementing of joints provided to be possible only under certain conditions which could not always be fulfilled. Further tests made between P.V.C. and Acrylic plastics, resulted in the selection of the latter material as being the most suitable for overall handling, construction and performance capabilities.

2.8 PUMPS AND BLOWERS

The selection of suitable pumps was given careful consideration to ensure that all the working conditions would be satisfied. These included operation and sealing of the impellar shaft at elevated temperatures, a low tendency to cavitate over the range of working conditions, and a careful appraisal of materials used in the pump casing itself.

To activate the air bearing and separation zones a reliable turbo-blower was selected.

2.9 TEMPERATURE CONTROL

The use of elevated process temperatures to permit an increase in processing speeds necessitates the holding of solution temperatures

to a greater accuracy than is required at lower temperatures. The volume of flow required from the pumps for the transport cushion provided considerable assistance in preventing temperature differentials in each module system. With the rate of flow established, and the heaters selected, the design of the tanks best suited for the design concept were carefully considered, to ensure accurate temperature control, and to keep the volume of solutions required to an absolute minimum.

2.10 FINAL BREADBOARD

The breadboard constructed to embody the results of the foregoing test and evaluation programs consists of a six module system, which is completely light sealed to permit processing tests to be conducted under normal daylight conditions. A light tight adapter is provided to permit use of a standard A9 magazine.

Electrical control systems are provided for solution heating temperature control and recirculation for each module.

Front and rear elevations of this breadboard model are included at the back of this report.

SECTION 3

3.1 CONCLUSIONS AND RECOMMENDATIONS

In the design concept and selection of equipment and materials for the wide film [ ] breadboard, continuous consideration was given to the requirements of the prototype [ ] processor.

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The objective of this consideration was that too far a departure from the design concept of the breadboard in the design of the prototype [ ] could very well introduce functional variations that might produce different sensitometric results. As a consequence, only minor changes are anticipated between the two.

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From this program, a clear picture can now be visualized of the prototype machine, incorporating the breadboard experiences combined with the dryer stage, into a compact mobile processor.

We are confident that the results of phase 1 of this program, as demonstrated in the breadboard model, fully justify the continuation of this contract into phase II.

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